

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON.

PALEONTOLOGY OF THE CRETACEOUS FORMATIONS
OF TEXAS—THE INVERTEBRATE PALEONTOLOGY
OF THE TRINITY DIVISION.*

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*I.—STRATIGRAPHIC DIVISIONS AND NOMENCLATURE OF
THE COMANCHE SERIES.*

It has heretofore been impossible to present faunal studies of the paleontology of the various horizons of the Comanche Series,

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†The writer desires to express his indebtedness to the many friends whose advice has assisted him in the preparation of this paper: to Messrs. T. W. Stanton, W. H. Dall, Alphens Hyatt, and F. H. Knowlton, of the United States Geological Survey, for aid in the determination of doubtful genera, and to Mr. J. L. Ridgway, artist, and Mr. C. W. Eddy, of Ware, Massachusetts, photo-engraver.

owing to the fact that the fundamental problems concerning the sequence and relative importance of its subdivisions had not been presented until lately, although the identity of the series, as a whole, was made known in 1886. Prior to that time most of its fossils had been described by Shumard, Roemer, and others, but it was supposed that the species all came from beds which were in some manner equivalents of the upper Cretaceous or the well known Meek and Hayden section. Since the writer ascertained that the Comanche Series was a distinct and lower Cretaceous formation he has spent several years in studying the subdivisions and their extent, in ascertaining the stratigraphic position of the fossils or faunas already described, and in arriving at a rational system of nomenclature.* These steps were necessary before the homotaxy of the series could be discussed.

In early papers by the writer,† pending more minute study of details, the Comanche Series was broadly divided into two divisions or convenient groups of strata, as follows:

(1) An Upper or Washita Division, so named because of its prevalent occurrence in the vicinity of Old Fort Washita, Indian Territory, whence some of the species, which I ascertained were peculiar to this division, were originally described by Professor Jules Marcou and the brothers Shumard. (2) A Lower, or Fredericksburg Division,‡ so named because many of its characteristic species were those described originally from the vicinity of Fredericksburg, Texas, by Dr. Ferdinand Roemer.§

In 1887, while studying the Cretaceous formations of Arkansas, the writer discovered that the beds of the Fredericksburg Division, so called, consisted of two well-defined groups of strata

* The Comanche Series of the Arkansas-Texas Region, by Robt. T. Hill: *Bull. Geol. Soc. of America*, vol. II, pp. 503-528.

† The Topography and Geology of the Cross-Timbers and Surrounding Regions in Northern Texas: *Am. Journ. Sci.*, vol. XXXII, April, 1887.

‡ It has been alleged (Third Annual Report Texas Geological Survey, p. 272, and *American Geologist*, January, 1893), that the term Fredericksburg Division was originated by Dr. Ferl. Roemer. Inasmuch as Dr. Roemer never recognized the existence of the Comanche Series, it is impossible to suppose that he named its divisions, and from none of his writings can such an inference be made.

§ The evolution of knowledge concerning the Cretaceous formations of Texas prior to the writer's publications is set forth in Bulletin 45 of the U. S. Geological Survey.

entirely distinct from each other in paleontologic characters, and that it could be appropriately made into two divisions. For the upper of these, which is composed of the *Caprina* limestone and the "Comanche Peak Group" of Shumard in part, the name Fredericksburg was retained, and to the lower the name Trinity Division was given, thus dividing the Comanche Series, more in accord with its natural grouping, into three great divisions, instead of two, as originally proposed.

Since the publication of his Arkansas report* the writer has devoted several years to the study of the Trinity Division in Texas and Indian Territory, and has more fully differentiated its beds from those of the overlying Fredericksburg Division, and, furthermore, ascertained that it constitutes a paleontologic and stratigraphic division of the utmost importance in the interpretation of the North American Cretaceous.

In the same report upon the Arkansas Cretaceous a preliminary description of the Trinity Division was made, separating it into a lower or arenaceous terrane, and an upper or calcareous terrane, for which, in a final paper† upon the stratigraphic subdivisions of the Comanche Series, read before the Geological Society of America at its Washington meeting, December, 1890, the names of the Trinity sands and Glen Rose beds were respectively proposed and the following general arrangement of the series given:

C. The Washita or Indian Territory Division.

10. The Denison beds.

9. The Fort Worth limestone.

8. The Duck Creek chalk.

7. The Kiamitia clays or *Schloenbachia* beds.

B. The Fredericksburg or Comanche Peak Division.

6. The *Caprina* and Goodland limestone.

5. The Comanche Peak chalk.

4. The *Gryphaea* rock and Walnut clays.

3. The Paluxy sands.

A. The Trinity Division.

2. The Glen Rose, or alternating, beds.

1. The Trinity, or basal, sands.

* The Neozoic Geology of Southwestern Arkansas, vol. II of the Annual Report, Geological Survey of Arkansas, 1888.

† Loc. cit.

II.—POSITION AND CHARACTERISTICS OF THE TRINITY DIVISION.

Fuller details concerning the extent and occurrence of the Trinity Division have been largely set forth during the past year in a publication by the writer,* and much of its stratigraphic details and some of the final maps as made by him and his assistants, Messrs. J. A. Taff, J. S. Stone, W. T. Davidson, and N. F. Drake, have been printed still later.†

The details of the formation can be appreciated by referring to the published descriptions of three typical sections, made at widely separated intervals, showing the increasing thickness of the beds to the southward.

The first of these, made by the writer while employed upon the work of the Arkansas State survey, is described in the report upon the Neozoic geology of southwestern Arkansas.‡

The second represents the beds as they occur in the vicinity of the Paluxy and Brazos rivers, in north central Texas, and was made by the writer and his assistants, Messrs. J. S. Stone and W. T. Davidson, and published in the report "On the Occurrence of Underground Water," § and later in the Third Annual Report of the Geological Survey of Texas. || In this region the beds of the Trinity Division attain an established thickness of about 475 feet.

The third and southernmost section was made along the banks of the Colorado river between Austin and the Paleozoic contact in Burnet county by the writer and his assistants, Messrs. J. A. Taff and N. F. Drake. The rocks of the Trinity Division attain unusual development in this region and are very satisfactorily exposed. A profile ¶ illustrating this section is published in the

* "On the Occurrence of Artesian and Other Underground Waters in Texas, New Mexico, and Indian Territory West of the Ninety-seventh Meridian" (pp. 41-166 of "Final Reports of the Artesian and Underflow Investigation, etc., to the Secretary of Agriculture." 52d Congress, 1st Session, Ex. Doc. 41, part 3, Washington, D. C., May, 1892).

† Report on the Cretaceous Area North of the Colorado River, by J. A. Taff. Austin, Texas, September, 1892.

‡ Op. cit., pp. 116-126.

§ Op. cit., pp. 111-112.

|| Op. cit., pp. 307, 310, 311.

¶ Loc. cit., pp. 90-91.

report upon the "Occurrence of Artesian Water," and much of the detail of the section given in the Third Annual Report of the Texas Geological Survey.* The thickness of the rocks of the Trinity Division in this region is about 500 feet. The beds have not been systematically studied in their extent south of the Colorado river.

From study of these sections it is concluded that the beds, as a whole, indicate a progressive and continuous series of sediments, representing subsidence from land through littoral to off-shore conditions, followed by renewed shallowing at its close. It consists of sands and conglomerates at its base, and grades upward into magnesian and chalky limestones. No sharp lines of demarcation can be drawn between the sands and limestones, so imperceptibly do they merge into each other.

The Basement Beds or Trinity Sands proper.—These consist mostly of unconsolidated fine conglomerate and sands of the nature locally known as pack sands, and contain, besides logs of silicified wood, occasional masses of firm, lustrous lignite of depressed oval cross-section, like those found in the Potomac formation near Muirkirk, Maryland. Large bones of vertebrates have also occasionally been found, notably near Millsap, Texas, Travis Peak post-office, and at Gypsum Bluffs, Arkansas, which are supposed to be the remains of Dinosaurs. It was owing to the occurrence of these bones that in an early paper these sands were at first termed the Dinosaur sands by the writer.†

The Glen Rose Beds.—Indurated layers of impure calcareous and yellow material succeed the sands, and become more calcareous and magnesian toward the top of the sections, but without any defined breaks in the sedimentation. In the medial and upper portions of the sections the magnesian and limestone strata assume great thickness and purity, and are separated by alternations of laminated, calcareous, and magnesian clays, as beautifully shown in the bluffs of Mount Bonnel, on the Colorado river, northwest of Austin.‡

* Loc. cit., pp. 265-309; also First Annual Report of Texas Geological Survey for 1889, 1890, p. lxxxv.

† Am. Journ. Sci., vol. xxxiii, April, 1887, p. 298.

‡ Photographs of the scenery and structure of the Cretaceous formations of Texas, made by the writer for the Texas State Geological Survey, can be procured from the Committee on Photographs of the Geological Society of America.

Molluscan and other invertebrate remains appear coincident with the calcareous beds, accompanied in some instances by plant and vertebrate remains, as at the plant beds three miles west of Glen Rose, Somervell county, Texas.

Aggregations of Species in Great Beds.—In various parts of the Glen Rose beds there are strata composed of shells of one predominant species, while in other cases there is an agglutination of shell fragments of many species in masses similar to the recent formation on the coast of Florida known as Coquina.

Coquina Beds.—These usually appear at the base of the Glen Rose beds or at the first appearance of marine mollusks in the series. In Arkansas, owing to greater alteration through calcification, they consist of much more indurated limestone material than in Texas. The massive beds are composed almost exclusively of small shells of many species, and usually have a dark-yellow color upon weathering. They outcrop at many places along the old military road between Antoine and Ultima Thule. Shell beds are especially well developed near Travis Peak post-office, near the Colorado river, where the Coquina beds are pure white in color and the shell fragments more siliceous and comminuted than in Arkansas.

The Oyster Agglomerate.—Near the base of the Travis Peak section is a stratum some four feet in thickness, composed exclusively of a fossil *Ostrea*, so poorly preserved that the specific nature cannot be ascertained, but which resembles *O. franklini* Coquand. A similar bed of *Ostrea franklini* occurs in the west bluff of the Little Missouri, three miles west of Murfreesboro, Arkansas.

The Vicarya Beds.—At Post Mountain, west of the town of Burnet, there is the remnant of a vast bed of agglomerate, composed entirely of the shells herein described as *Vicarya lujani* de Verneuil, cemented by a hydrocarbon matrix, probably grahamite. This bed is some ten feet in thickness, and is evidently near the base of the Glen Rose beds.

The Orbitulites Chalk.—Near the base of the Bluffs of the Colorado, about the middle of the Glen Rose beds (Upper subdivision) is a stratum of ten feet or more in thickness, composed entirely of a massive white chalk, studded with the minute shells of the foraminifera *Patellina (Orbitulites) texana* Roemer. This chalk extends southward into Hays, Comal, and adjacent counties.

The Requinia ("Caprotina") Limestone.—At Granbury and in southwestern Parker county there is a vast agglomerate composed entirely of the shells and casts of *Requinia texana* Roemer, to which Dr. B. F. Shumard gave the name "Caprotina limestone." This occurs well up in the Glen Rose beds, about one hundred feet from their top. There is a similar bed in the ravine near the east foot of Mount Bonnel, west of Austin. As shown by the writer,* there is another horizon of Caprotina limestone higher in the Comanche Series.

The Nerinea Flags.—The summit of the Glen Rose beds, as seen in Mount Bonnel, consists of alternations of dimension layers of firm crystalline limestone and pseudo-oolitic marls. Some of these dimension layers in the peak of Mount Bonnel are composed almost exclusively of calcified forms of *Nerineas*.

III.—FOSSILS OF THE TRINITY DIVISION.

The beds contain many plant, vertebrate, and invertebrate remains, which occur either separately or in association, as at one locality in the bed and banks of Paluxy creek, three miles west of Glen Rose, Texas. The more sandy basement beds, or Trinity sands, are, as a rule, deficient in organic remains, with the exception of silicified wood and lignite, although occasional vertebrates and invertebrates are found.

The lower beds of the Glen Rose subdivision abound in invertebrate remains, most of which, however, are but badly preserved casts. The Glen Rose beds also contain occasional plants and vertebrates, especially in their lower portion, where they grade into the underlying sands.

The upper beds of the Glen Rose Division are less abundant in fossil remains, and these are very poorly preserved as casts. The plants of the basement Glen Rose beds have been collected by Professor Lester F. Ward, of the United States Geological Survey, and studied by Professor W. M. Fontaine, of the University of Virginia. They are now in course of publication in the Proceedings of the United States National Museum.† The small but interesting collections of vertebrate remains, with the exception of a lepidotoid fish in the hands of Professor Cope,

* First Annual Report of the Geological Survey of Texas, 1889, Austin, 1890, p. 133.

† Proc. U. S. Nat. Mus., vol. xv, pp. —, pls. xxxv–lxiii.

have not been studied. In this paper will be presented a preliminary study of its invertebrate fauna.

The following is a list of the fossils collected or observed by the writer from all the beds of the Trinity Division in Arkansas and Texas :

Foraminifera :

Patellina texana (Roemer).

Echinodermata :

Epiaster (?) sp. indet.

Vermes :

Serpula paluxiensis sp. nov.

Molluscoidea :

Genus indeterminate.

Mollusca :

Anomia texana sp. nov.

Ostrea franklini Coquand.

Ostrea franklini ragsdalei var. nov.

Pecten stantoni sp. nov.

Modiola branneri sp. nov.

Leda harveyi sp. nov.

Cucullava gratiota Hill.

Cucullava comanchensis sp. nov.

Cucullava terminalis Conrad.

Barbatia parva-missouriensis Hill.

Trigonia stolleyi sp. nov.

Trigonia crenulata Roemer.

Chione (?) *decepta* sp. nov.

Eriphylla pikensis Hill.

Requienia texana (?) (Roemer).

Monopleura marcida White.

M. pinguiscula White.

Corbicula arkansaensis Hill.

Cardium (?) *sevierense* Hill.

Protocardia sp. indet.

Pholadomya knowltoni sp. nov.

Pholadomya lerchi sp. nov.

Pleuromya (?) *henselli* sp. nov.

Isocardia (?) *medialis* Conrad.

Natica (?) *texana* Conrad.

Viviparus natica (?) *rossatotensis* Hill.

Cylindrites (?) sp. indet.

Buccinopsis (?) *parryi* Conrad.

Tylostoma pedernalis (Roemer).

Vicarya branneri sp. nov.

Nerinea austincensis Roemer.

Neritina sp. indet.

Neumayria walcotti Hill.

Acanthoceras (?) *justinae* sp. nov.



Arthropoda :

Cypridea texana sp. nov.

Vertebrata :

Lepidotus.

Crocodyla.

Dinosauria.

Chelonia.

Plantæ :

Many species, now in course of publication by Professors Ward and Fontaine, together with undetermined species resembling *Araucarites*, figured on plate 1.

IV.—AGE AND SIGNIFICANCE OF THE TRINITY DIVISION.

With the exception of the genera *Requienia* and *Monopleura*, the above list contains none of the hitherto familiar types of fossils found in the overlying Fredericksburg and Washita Divisions, such as the characteristic *Echinodermata*, *Radiolites* (alleged *Hippurites*), *Gryphæus* of the *Pitcheri* group, *Erogyras*, or *Schloenbachiate Ammonitidæ*, but possesses a molluscan fauna peculiarly its own, so far as America is concerned, which, accompanied by a well-preserved flora and vertebrate fauna, affords the first satisfactory and complete data for an age classification of the subdivisions of the North American Lower Cretaceous formation, and will enable us to more thoroughly interpret the succeeding divisions. This association of vertebrates, plants, and marine mollusca is a most important fact in the correct determination of the age of these beds, and they all apparently agree in conclusions.

Concerning the interpretation of the foregoing fossils, the following facts may be stated: The plants, as determined by Pro-

fessors Ward and Fontaine, originally in the Potomac region,* were long since referred by them to the Wealden, before they were known to occur in the magnificent Texas stratigraphic series.

The vertebrates have never been systematically studied nor collected, but the genera found all occur in the Lower Cretaceous of Europe.

Of the invertebrates the ostracoid crustacean *Cypridea* of the Glen Rose lower beds is in Europe as in Texas, a prominent feature of the Wealden (Lower Neocomian) beds.

The foraminifer *Patellina* (*Orbitulites*) *texana* Roemer is indistinguishable from the *Orbitulites*, which characterizes the Upper Neocomian of France, and occurs there under lithologic conditions similar to those in Texas.

Of the Pelecypod mollusca proper the *Anomia* is indistinguishable from the *Anomias* of other ages.

The only *Ostrea* (*O. franklini* Coquand) seem identical with the figures of a form which has been described under many specific names from the Upper Jurassic, and Lower Cretaceous of Europe.

Pecten stantoni belongs to a group of the *Pectinida*, which has great specific development in the Neocomian of France, Spain, and Portugal.

Modiola, *Leda*, *Cucullæa*, *Protocardia*, *Corbicula*, *Pholadomya*, and the doubtful form called *Isocardia* have a wide range in the geologic column, but the forms found in the Trinity Division have a general varietal resemblance to those of the Neocomian.

The only well-defined species of *Trigonia* (*T. stolleyi* sp. nov.) belongs to the scabrate forms peculiar to the Cretaceous and later epochs. This is an important fact against the possible Jurassic age of the beds.

The aberrant genera, *Requienia* and *Monopleura*, which abound in the Glen Rose beds, are both characteristic Lower Cretaceous genera, occurring abundantly in Europe in the Neocomian beds and not ranging higher than the Cenomanian. In describing *Requienia* (*Caprotina*) *texana*, Roemer asserted that it was hardly distinguishable from the characteristic *Caprotina lonsdallii* of the Neocomian of France.

Of the Gastropoda, the genus *Vycaria* is represented by *V. branneri* resembling a peculiar species of the European Neo-

* See various papers by Professors Lester F. Ward and W. M. Fontaine on the Potomac flora of the North Atlantic coast.

comian, *V. lejani* De Verneuil and which in every variation is identical with the figures of the European species.

Natica (*Tylostoma*) *pedernalis* Roemer is characteristic of the Tylostomas of the Neocomian of France, Spain, and Portugal.

Of the *Nerineas* in the Texas beds all have the archaic form of the Jurassic and lower Cretaceous (*Neocomian*) *Nerineas*.

Only one echinoid is found in the Trinity Division, *Epiaster* (?), but this is of the older Cretaceous aspect of the European forms.

Of the *Ammonitidæ*, which in Europe are most relied upon for the classification of subdivisions of the Cretaceous, it may be said that the Comanche Series below the Washita Division is very deficient in these, only four species being known in America. Of two of these only three individual specimens have been found, while the European Neocomian abounds in many species and genera. Of the two genera with one species each found in the Trinity Division, it may be said that one of them, *Neumayria*, belongs to a genus which occurs in the Purbeckian, or uppermost Jurassic, and Wealden of Europe, and hence may be accepted as strong evidence that these beds are not of late Cretaceous age. The other species, *Acanthoceras* (?) *justine*, is too poorly preserved to be of criterional value.

While the writer has throughout placed the Trinity Division in the Cretaceous, he tried to defer final discussion of their age until opportunity should arrive for careful study of these fossils. Owing to constant labors in the field upon the more important stratigraphic problems, this opportunity did not arrive until now. At the time the Arkansas report* was written it was held that the Trinity beds might prove to be Jurassic, but the careful revision here presented tends to remove this doubt and enables us to assert their Cretaceous age with more assurance. Whatever doubt may have been inferred from any expressions in previous publications,† it may now be stated positively:

*Op. cit.

† Through two unfortunate lapses in the typography of his former papers the attempt has been made to show that the writer did not hold the Cretaceous age of the Trinity Division, notwithstanding his repeated publications to the contrary. One of these is caused by the typographic error on page 84 of the report "On the Occurrence of Underground Waters," etc., Washington, May, 1892, where the clause "which are assumed to be the base of the true Cretaceous" is made to modify the words "Walnut clays," instead of "these beds," *i. e.*, the Trinity. The other lapse was of a somewhat similar nature in the previous publication on The Comanche Series of the Texas-Arkansas Region.

1. That there is not a single invertebrate species in the Trinity Division of exclusive Jurassic age, which would justify placing the beds in that period.

2. The genera all occur in the Cretaceous formations of the rest of the world, and many of them, such as *Requienia* and *Monopleura*, occur only in the Cretaceous. Hence the beds are Cretaceous.

3. The beds of the Trinity Division are of lowest Cretaceous age, Neocomian, because the genera all occur in the Neocomian or lowest Cretaceous of other countries, and because they contain none of the characteristic upper or middle Cretaceous forms.

Finally it may be stated that from the above comparison of the life of the Trinity Division with the Cretaceous life of Europe it is evident that it shows not only a resemblance, but a remarkable homotaxial similarity with the Lower or Neocomian of that country, the lowest faunas resembling the Wealden or Lower Neocomian, and the Upper Glen Rose beds the Middle and Upper Neocomian, especially as developed in the region of the Jura and in Spain and Portugal.

V.—DESCRIPTIONS OF SPECIES.

FORAMINIFERÆ.

Patellina texana (Roemer).

Plate I, Figs. 2 (copied after Roemer), 2*a*, 2*b*, 2*c*, 2*d*.

Orbitulites texana Roemer. Die Kreidebildungen von Texas, p. 86, plate x, figs. 7*a*, *b*, *c*, *d*.

"Shell minute, attaining one-eighth of an inch in diameter; orbiculate, shield-shape, convex above, obtusely conical; central eminence umboniform, ornamented with close, fine, concentric striae, otherwise smooth; lower part flat, slightly concave, with irregular, radiating, granular rugae, as if perforated by worms."—Roemer.

Roemer said: "This species certainly belongs to that group of Lamarek's genus *Orbitulites*, which D'Orbigny separated as a distinct genus *Orbitolina*." Careful microscopic study of the interior structure by the writer shows the granular structure illustrated in figs. 2*a*, 2*b*, and that it belongs to the genus *Patellina* of Williamson.

This important foraminifer was first found by Roemer on the upper branch of the Pedernalis, associated with *Tylostoma pederalis*. I have found its true position to be in the medial portion of the Glen Rose beds, where, as on the Colorado near the mouth of Bull creek, it occurs in a massive chalk some ten feet thick. The "*Orbitolina*" beds are among the most characteristic and distinguishing features of the upper Neocomian of Europe, in the region of Jura, and in Dauphine, Portugal, and Spain. Their occurrence in a similar stratigraphic position in the Texas region is additional evidence of the Neocomian age of the Glen Rose beds. This Texas form has also been reported by Karsten from the Neocomian beds of Venezuela.

ECHINODERMATA.

Epiaster (?) sp. indet.

Only one echinoid has come under the writer's observation from the Glen Rose beds. It occurs about midway in the section, near Bull creek, Travis county, and in Somervell county, Texas. This has been submitted to Professor W. B. Clark, of Johns Hopkins University, who writes as follows concerning it: "I am inclined to think it not only a new species, but a new genus." The specimens are left in Professor Clark's hands for future determination.

VERMES.

Serpula paluxiensis sp. nov.

Plate I, Figs. 4, 4a, 4b.

Cylindrical tubiculate, marked by concentric lines of growth; occurs in colonies, radiating out from a central nucleus. Individuals several inches long, but it is impossible to trace complete length of specimens, owing to mode of growth. Adult specimens average one-eighth inch in diameter.

This is one of the most abundant forms in the basement horizon of the Glen Rose beds, and occurs attached to lignite, shells of *Ostreidae*, and casts of other mollusks, or in immense colonies or spherical masses, some of which in Paluxy creek, averaging three feet in diameter, are composed entirely of this species.

The *Serpulas* have such wide geologic range and so few specific characters that they are of little value in geologic diagnosis.

Occurs at gypsum bluffs of the Little Missouri, and in great abundance at the plant bed near Glen Rose, and also throughout the extent of the lower fossiliferous Glen Rose beds in Texas.

MOLLUSCOIDEA.

Genus indeterminate.

Microscopic oval cells about one millimeter in length, growing in colonies attached to shell of *Serpula paluxiensis* and other forms; cells not overlapping, but in close contact with each other, forming a single layer of delicate net-work.

The cells of this species have not the pyriform shape or imbricated arrangement of *Membranipora* or the vibracular cells of *Lunulites*, and hence are assigned to no generic position at present. This form is the only one belonging to this order yet found in these beds. It occurs attached to other shells in the beds of the plant locality on the Paluxy near Glen Rose, Texas, at the base of the Glen Rose beds.

MOLLUSCA.

Anomia texana sp. nov.

Plate I, Fig. 5.

Anomia sp. indet. Hill. Arkansas Geological Survey, Annual Report 1888, vol. II, p. 135.

Thin, discoidal, indistinguishable specifically from many species of this genus; right or lower valve attached, concentrically laminated; left upper valve arched and very irregular; seldom exceeds one-half inch in greatest diameter.

This species abounds in the earliest fossiliferous horizon of the Trinity Division, such as the beds in Paluxy creek, west of Glen Rose, and at the gypsum bluffs of the Little Missouri, in Pike county, Arkansas. It also occurs in most of the localities throughout the extent of the Glen Rose beds.

Ostrea franklini Coquand.

Monographie du Genre *Ostrea*, p. 58, plate xxiii, figs. 8-10. Hill, Arkansas Geological Survey, Annual Report 1888, vol. II, plate v, figs. 1-18a; plate vi, figs. 19-25; plate vii, figs. 28-30.

The general aspects and variation of this characteristic oyster of the Trinity Division have been fully described and figured in my Arkansas report. Professor Marcou in a review of this work* has divided the form into many species, but the writer, from his extensive study of the occurrence of the specimens *in situ*, still believes in the unity of the species, although in Europe it has doubtless been the custom of earlier paleontologists to make many species out of variations.

Choffat† figures and describes from Portugal *O. barrosi*, a form which resembles a variety of *O. franklini* found at Glen Rose.

This species occurs in great abundance throughout the Trinity Division, especially at the plant beds near Glen Rose, at the base of the Glen Rose beds in the Colorado section, and in a similar horizon throughout the Glen Rose beds in Arkansas and in Texas.

It is interesting to note that none of the true *Gryphaea* or *Ecogyra* have yet been found in the Trinity Division.

Ostrea franklini ragsdalei var. nov.

Plate I, Fig. 6.

Shell acuminate, oblong, marked by numerous, regular longitudinal costae; beak of large valve prolonged, costate, sub-cylindrical.

Several incomplete specimens of the larger valve of this species were procured from the fauna at the plant bed near Glen Rose. The outline is somewhat similar to that of *O. franklini* Coquand, but the larger valve is much more round, the point more prolonged and characterized by the strong costae which do not appear upon the adult specimens of the *O. franklini* elsewhere found.

* American Geologist, vol. IV, December, 1889, pp. 359, 360.

† Recueil de Monographies Stratigraphiques Sur le Système Crétacique du Portugal, par Paul Choffat. Lisbon, 1885, p. 37, plate iii, figs. 7, 8, 9, 10, 11, 12.

This variety is named for Mr. G. H. Ragsdale, the naturalist, of Gainesville, Texas.

Thus far this variety has only been found at Glen Rose.

***Pecten stantoni* sp. nov.**

Plate II, Fig. 3, 3a.

Shell small, one and one-half inches in length, strongly eared, and ears rugose, the right one (not shown in figure) being marked by a deep fold. The surface of the larger valve is marked by strong, flattened, double ribs, each with a sinus its entire length, alternating with small single ribs, and by minute cross-lines. This marking distinguishes it from the *Vola*-like forms of the upper half of the Comanche Series. The smaller valve is not known.

This beautiful species occurs in the molluscan fauna at the plant bed on Paluxy creek, near Glen Rose; only three specimens have been found. Two of the specimens were very perfect, but were unfortunately lost in the removal of my collections from Cornell University.

This species is named for Mr. T. W. Stanton of the U. S. Geological Survey.

***Modiola branneri* sp. nov.**

Plate V, Figs. 8, 9, 10.

Modiola sp. indet. Hill. Arkansas Geological Survey, Annual Report 1888, vol. II, p. 133, plate II, figs. 18, 19.

Shell small, elongate, from one-half to one and three-quarters of an inch in length, elongated sub-triangular, greatly thickened at umbonal region; umbones pronounced and rapidly narrowing to a rounded point; anterior portion somewhat flattened; posterior portion attenuated, thin, and strongly curving in outline; surface smooth, lustrous, marked by fine lines of concentric growth and faint radiating striae.

This well-preserved little *Modiola* occurs sparingly in the lower Glen Rose beds at the gypsum bluffs of the Little Missouri, Arkansas, and in the plant bed near Glen Rose. It was originally figured, but not named, in my Arkansas report.

Leda (?) harveyi sp. nov.

Plate I, Figs. 7, 8.

Shell minute, one-sixteenth to one-eighth of an-inch in length, elongate, smooth, concentrically striate; beaks situated at anterior third, blunt, thick, and recurving; posterior cardinal margin elongate, straight, or slightly concave; pallial margin straight or slightly sinuous; anterior cardinal margin short, straight; anterior margin very slightly rounded at base; posterior margin angular, short, and straight; anterior half of shell thick, subglobular; posterior half elongated, rapidly thinning posteriorly, and sometimes marked by a strong angular ridge extending from beak to union of pallial and posterior margin; cardinal area not exposed so as to show hinge mechanism.

This minute shell occurs in great masses, resembling small black specks in a calcareous cement, which under the magnifying glass reveals the outline shown in the figures; the hinge mechanism not seen.

Found thus far only at the plant beds of the Paluxy, near Glen Rose.

Named in honor of Mr. J. W. Harvey, who first collected from this locality, but died before the collections could be published.*

Cucullæa gratiota Hill.

Arca gratiota Hill. Arkansas Geological Survey, Annual Report 1888, vol. II, p. 133, plate 14, figs. 2, 2a. Described and figured in my Arkansas Report as *Arca gratiota*. Occurs also in plant beds near Glen Rose, Texas, and in bluffs of Colorado.

Cucullæa comanchensis sp. nov.

Plate III, Figs. 1, 2.

Cordate, globose, thicker and higher than long, subquadrate in lateral aspect; posterior margin strongly truncate, pallial margin gently rounded; anterior margin short and truncate; exterior of cardinal area elongate and broad; umbones small, high, and incurved, but not touching; shell thick, rough, and marked by strong, irregular, rugose lines; hinge mechanism not visible.

* See American Geologist, October, 1892.

This is one of the most characteristic species of the very base of the Glen Rose beds in Parker, Hood, and Comanche counties, and is the form which the writer once inferred to be analagous to *Ambonicardia cookii* Whitfield,* from the Raritan clays of New Jersey, which the fragments then found strongly resembled in outline and marking. The discovery of the specimen here figured, however, for the first time affords evidence for their satisfactory generic identification.

The specimen figured was found about three miles east of Millsap, Texas, at the contact of the Trinity sands and the calcareous Glen Rose beds. I have also found the species near Springtown, Parker county, and at Comanche, in the same horizon.

***Cucullæa terminalis* Conrad.**

(See Report United States and Mexican Boundary Survey Washington, 1857, vol. i, p. 148, plate iv, figs. 2*a* and *b*.)

Casts of this species are frequently met with in the Glen Rose beds. The shell has not yet been found.

***Barbatia parva-missouriensis* Hill.**

This species, from Pike county, Arkansas, was described and figured in my Arkansas Report, p. 133, plate iv, figs. 4*a*, 4*b*, 5, and probably fig. 22, of plate ii, of same report.

***Trigonia stolleyi* sp. nov.**

Plate III, Figs. 3 and 5.

Semi-lunate in general outline, beaks well forward and strongly recurved; anterior and pallial margin a strong continuous curve; posterior portion elongated with truncated posterior margin; cardinal area compressed. Surface marked by flexuous, noduled costae, about twenty-two in number, narrow and high, separated by broad intercostal areas as in *T. alaeformis* Lmk.; depressed cardinal area bordered on its outer side by a long narrow groove and marked by cross-ribs, flexing anteriorly.

This *Trigonia* differs from *T. emoryi* Conrad, of the Washita Division, in its general outline and entirely distinct surface mark-

*See Report of Arkansas State Geological Survey for 1888, vol. ii, p. 126.

ing. (See U. S. and Mexican Boundary Report, vol. 1, p. 148, plate iii, figs. 2*a*, *b*, *c*.) Occurs abundantly in the plant beds of the Paluxy. The species is named for Professor G. W. Stolley, of Austin, Texas, whose work as a collector is esteemed in both Europe and America.

Trigonia crenulata Roemer.

Plate III, Fig. 4.

Roemer. Kreidebildungen von Texas, p. 51, plate vii, fig. 6.

This species, described by Roemer from imperfect casts, may be the same as *T. stolleyi*. The specimen here figured was collected from the bluffs of the Colorado near Bull creek, Travis county.

Chione (?) decepta sp. nov.

Plate I, Figs. 9 and 10.

Shell sub-triangular or elliptical in outline, compressed in cross-section from base to umbones; umbones forward of center, small, and touching each other; lunular area small, cordate oval; pallial margin widely rounding; anterior cardinal margin concave, shorter than posterior; posterior cardinal margin long, slightly convex, asymmetrical; cardinal mechanism not shown; surface marked by long concentric and very faint irregular lines, anterior muscular scar elongate, rounded; posterior muscular impression flat, depressed at extreme posterior end.

The casts of this form are abundant throughout the Glen Rose beds, but its generic position is uncertain. It may possibly belong to the *Carditidae*. In the hills north of Lampasas, near the top of the formation, the specimens occur in great abundance with the shell preserved in calcite, showing the exterior structure. Conrad's species of *Astarte texana*,* described from a cast from an unknown locality, has a superficial resemblance to this form, according to his description and figures, but it is more triangular and otherwise different, as seen by comparison with his type in the National Museum.

* U. S. and Mexican Boundary Report, vol. 1, p. 152, plate v, fig. 9.

Eriphyla pikensis Hill.

Plate IV, Figs. 4, 5, 6.

Corbicula pikensis Hill. Arkansas Geological Survey, Annual Report 1886, vol. II, p. 134, plate II, figs. 13, 13a, 14, 15, 16, 17.

This form was originally figured by the writer under the generic name of *Corbicula*, and is very closely allied to the so-called *Cyrena astartiformis* Koch and Dunker, from the Wealden of Germany. Professor Marcon has referred it to the *Astartidae*, but it is undoubtedly a species of the genus *Eriphyla* of the *Astartidae* distinguished by the lateral teeth.

It occurs in great abundance in Pike county, Arkansas, and sparingly at the plant bed of the Paluxy, near Glen Rose, Texas.

Requienia texana (?) (Roemer).

Caprotina texana Roemer. Kreidebildungen von Texas, p. 80, plate v, figs. 2a, 2b.

A *Requienia*, provisionally referred to *R. texana* Roemer, is one of the prominent species of the Glen Rose beds and occurs in massive agglomerate some twenty feet in thickness at Glen Rose, Thorp Springs, Granbury, and in southern Parker county. In Roemer's description he asserts that it is indistinguishable from *Requienia lonsdalli* D'Orb., of the French Neocomian, except by its thicker shell. It is desirable to closely compare this form with *R. patagiata* White.* Dr. Roemer says that the latter species is entirely distinct, the larger valve of *R. texana* not being so elevated as in *R. patagiata*. In the abundant material collected by the writer this distinction does not always hold good, yet there is a general difference in appearance, especially in the larger size and more rounded character of the valves of the Glen Rose forms, which may make it a distinct species from either of these. The type forms of the *R. texana* Roemer and the *R. patagiata* White occur in the horizon which we at present accept as the Caprina limestone, while the *Requienias* of the agglomerate at Granbury and at the base of the Colorado section occur several hundred feet below them, and may prove a distinct species.

Requienia is the lowest occurring genus of the aberrant Cham-

* *Requienia patagiata* White. U. S. Geological Survey, Bulletin No. 4, p. 6, plate v, figs. 1-8.

idae, with the exception of *Diceras*, a Jurassic form, and is abundant in the Neocomian formation of Spain, France, and Portugal.

***Monopleura marcida* and *M. pinguiscula* White.**

Bulletin U. S. Geological Survey, No. 4, p. 8, plate 5, figs. 1-8.

Casts and moulds of *Monopleura* occur in great abundance in the Colorado section, especially at the base of Mount Bonnel, near the mouth of Bull creek. It is impossible to make a correct diagnosis of these, owing to the fact that the smaller valves, so abundant in the Caprina limestone, have not been found in the Glen Rose beds, but there is a general resemblance of the larger valves to the two species named.

The genus *Monopleura*, according to Zittel, has wide distribution in the Lower Cretaceous, occurring in the Neocomian of Provence and the Jura mountains, and seldom ranging higher. In America the genus culminates in the Caprina limestone and is not known later.

***Corbicula arkansaensis* Hill.**

Arkansas Geological Survey, Annual Report 1888, vol. II, p. 133, plate II, fig. 20; plate IV, figs. 3, 3a, 6.

This species was originally figured and described in my Arkansas report. It occurs in Pike county, Arkansas, near Murfreesboro, and at the gypsum bluffs of the Little Missouri. It is less abundant in the Texas beds.

***Cardium* (?) *sevierense* Hill.**

Arkansas Geological Survey, Annual Report 1888, vol. II, p. 134, plate II, figs. 21, 21d.

This form has only been found in Arkansas, at the locality from which it was described in my Arkansas report.

***Protocardia* sp. indet.**

Small casts, three-quarters of an inch in length, globose; surface marking, very fine lines.

The Comanche species of the genus *Protocardia* need careful revision, and this form may be found to belong to some of the numerous species already described. This species is distinguished only by a smaller size than that of all the other forms described. It occurs sparsely in the beds near Glen Rose.

Pholadomya knowltoni sp. nov.

Plate II, Figs. 1, 2.

Choffat (Matériaux pour L'Étude Stratigraphique et Paléontologique de la Province D'Angola, Geneva, 1888, p. 84, plate v, figs. 1-3) describes under the name of *P. pleuromyaformis* a form indistinguishable from this species. His description, as follows, corresponds fully with our species:

"Equivale, inequilateral; swollen below the beaks; anterior border rounded and completely closed; posterior border compressed at the extremity, which is slightly turned upward, truncated and slightly gaping; beaks small, elevated, strongly inflexed and in contact with each other; cardinal portion of anterior border sloping and its continuation strongly rounded; the posterior cardinal border straight, slightly elevated to its extremity; anterior face blunt, behind which a slight, faint groove extends from the beak to the pallial border. The surface of the shell is marked by irregular longitudinal plications."—Choffat.

This shell can in no way be distinguished from the excellent figures and descriptions given by Choffat of *Pholadomya pleuromyaformis*, from Dombey, on the west coast of Africa, where a fauna closely allied to the Comanche series occurs, but of course their identity cannot be positively established without comparison of specimens. The faint grooves from beak to pallial border are not brought out well in our figures.

The form first appears in America in the medial portion of the Glen Rose beds of the Colorado river section, near the mouth of Bull creek, and again appears in the supposed Caprina limestone at Austin, in the Fredericksburg Division.

Pholadomya lerchi sp. nov.

Plate IV, Fig. 3.

Outline subpyramidal in lateral aspect; length, three and one-half inches; height, two and one-half inches; greatest thickness, two inches; beak situated at anterior third, of medium proportions; anterior margin semicircular in outline from beak to pallial margin, into which it merges by a continuous curve; pallial margin a continuous curve with the anterior margin, and rapidly increasing in curvature posteriorward, terminating obtusely with the truncated posterior margin; posterior margin sharply truncate, about one inch in length; anterior umbonal margin very short, marked by a small depression immediately below the

umbone; posterior umbonal margin elongate, sloping posteriorly at an angle of about 30 degrees from the umbone; this margin is straight when viewed laterally, but bends strongly outward toward the gaping posterior margin, with which it unites by a gentle curve; surface marked by strongly rounded ribs and grooves, subconcentric, sinuous and uniting with each other at a common groove which is parallel with the anterior margin.

Only a single poorly preserved cast of a right valve of this species has been found, the anterior portion of which is not visible. It was collected in the heavy conglomerate which marks the base of the Comanche Series at its contact with the Carboniferous formation, on Sycamore creek, Burnet county, Texas, near the crossing of the Burnet and Travis Peak roads. The species is named for Dr. Otto Lerch, of the Louisiana State Geological Corps, who, as a Texan, has made valuable contributions to the knowledge of his State.

Pleuromya (?) henselli sp. nov.

Plate IV, Figs. 1, 2.

Shell elongate-elliptical; length, three and one-quarter inches; height, two inches; umbones anteriorly-subcentral, round, and not prominent; anterior margin strongly rounded, continuing by curvature into the pallial margin; pallial margin elongate, slightly curved; posterior margin sub-truncate, slightly gaping; anterior umbonal margin sinuous, slightly gaping; posterior umbonal margin about one-third longer than anterior; interior and hinge mechanism not seen.

The generic position of this species is very doubtful; but, inasmuch as it is one of the most characteristic casts of the Glen Rose beds in the Colorado River section, it is important that it should be here figured. The species has a resemblance to *Thracia myæformis* White, but differs in some details.

Isocardia (?) medialis (Conrad).

Plate II, Figs. 4, 5; plate III, Fig. 6.

Cardium mediale Conrad, U. S. and Mexican Boundary Report, vol. 1, p. 149, plate iv, figs. 4a, b.

Conrad described this form as follows:

"Cordate equilateral, ventricose; base profoundly and nearly regularly rounded; beaks prominent; posterior margin truncated, direct."

To this I would add :

Variable in shape; shell thick, concentrically striate; beaks inturned as in *Isocardia*; anterior muscular impression very prominent, angular on anterior side; posterior muscular impression faint, large in area, almost indistinguishable; posterior margin truncate in normal specimens. Surface marked by strong concentric rugose lines.

The generic position of this form is not satisfactory, because the hinge structure has not been found. It is clearly not a *Cyprina*, although sometimes similar forms are referred to that genus by paleontologists in Europe; neither is it a *Cardium* as described by Conrad.

This is one of the most numerous, conspicuous, and characteristic species of the Glen Rose beds; it occurs as shellless casts by the thousands throughout the vertical and geographic extent in Texas and Arkansas, beginning in the lowest fossiliferous horizon and extending to the top.

A few specimens were found about ten miles west of Glen Rose, upon which fragments of the thick calcified shell structure were preserved, showing it to have a concentrically striated surface and the anterior cardinal margin and beaks to be as in *Isocardia*, as shown on plate vii, fig. 1.

The form varies greatly in shape, owing to the compression and distortion it has undergone in the strata. One of the extreme variations from the normal is illustrated on plate ii, fig. 5.

***Natica* (?) *texana* Conrad.**

U. S. and Mexican Boundary Survey, p. 157, plate xiii, figs. 1a, b.

This species is of rare occurrence in the beds at Glen Rose. It is not a *Natica*, but inasmuch as only casts are preserved its generic position cannot otherwise be stated.

***Viviparus* (*Natica* ?) *cossatotensis* Hill.**

Arkansas Geological Survey, Annual Report 1888, vol. ii, p. 130, plate iii, figs. 4, 4a, 5, 5a.

This form was originally described in my Arkansas Report from an isolated locality in Sevier county. Many consider it a *Natica*, but it is too imperfect to assert its generic position with certainty. The writer inclines to the belief that it is a fresh or brackish water form.

Cylindrites (?) sp. indet.

The writer has collected from the base of the Glen Rose beds in Parker county a few specimens of a small gasteropod very much resembling *Cylindrites bullatus* Lye. and Mort. Unfortunately the specimens have been lost.

Buccinopsis (?) *parryi* Conrad.

Plate VI, Fig. 1.

U. S. and Mexican Boundary Report, p. 158, plate xiii, figs. 4a, b.

B. Conradi Hill. Arkansas Geological Survey, Annual Report 1888, vol. II, p. 130, plate iii, figs. 2, 2a.

Conrad describes this species as follows:

"Subpyriform; longitudinally undulated and ornamented with rugose, revolving lines, spire scalariform; aperture large and patulous." Conrad also says: "Under this name I have described a cast which cannot be referred to any known genus; it is certainly not a true *Buccinopsis*, nor can its generic character be determined because of poor preservation."

The writer has found casts of this form in great abundance in the lower fossiliferous horizons of the Glen Rose bed at gypsum bluffs of the Little Missouri, in Arkansas, and at Glen Rose. In some instances the casts show marks in the shape of depressions extending across the lower whorl and the sutures are very deep and distinct. The whorls and spire of a more perfect specimen, shown in plate vi, fig. 1, are six in number and very flat and angular at their upper edge. Whatever may be the true generic position of this form, it is a very useful stratigraphic aid to the student of the Glen Rose beds. The form is readily distinguishable from *Tylostoma pedernalis* Roemer by its greater number of whorls and entirely different outline of the aperture.

Tylostoma pedernalis (Roemer).

Plate VI, Fig. 2.

Natica pedernalis and *N. praevalidis* Roemer. Kreidebildungen von Texas, p. 43, plate iv, figs. 1a, b; plate iv, figs. 1a, b.

"Shell large, ovate; whorls flat, angular above; lowest or basal whorl three times as high as the spire; spire composed of three coils. Aperture, elongate ovate."—Roemer

Dr. Roemer described this large and abundant species of the Glen Rose beds from specimens collected on the Pedernalis river. He also described *Natica* (*Tylostoma*) *pragrandis*, which he asserted differed only by its larger size.

The species occurs in the greatest abundance throughout the extent of the Glen Rose beds in Arkansas, Texas, and Mexico, and is preserved only as casts, without shell structure. From observations of hundreds of individuals, I am of the opinion that the two species of Roemer are identical.

These forms are indistinguishable from many species described from the Neocomian of France and Spain, where the genus *Tylostoma* has its culmination, ranging, according to Zittel, from the Upper Jurassic. *Tylostoma similimum* Choffat, from Portugal, a characteristic Neocomian form, is quite closely related, if not identical with the Texas species. It also resembles *N. gigas* Bonn. of the Jurassac.

The specimen figured here is a large flattened individual, illustrated in order to show the size and variation in comparison with the typical forms figured by Roemer.

This form occurs throughout the Neocomian of Mexico, in Venezuela, Bogota, and on the central Pacific coast of South America, and is one of the distinguishing fossils of the Glen Rose beds.

***Vicarya branneri* sp. nov.**

Plate V, Figs. 1-7.

Pleuroccra strombiformis (Schlotheim) Hill. *Neozoic Geology of Southwest Arkansas*, p. 129, plate ii, figs. 1, 2, 3, 4, 5, 6, 7, 7a, 7b, 8, 9, 10, 11, 12, 12a; plate iii, figs. 6, 6a, 6b, 6c, copies of European figures.

Compare—

Vicarya helvetica Verneuil and De Lorière. *Description des Fossiles du Néocomien Supérieur de Utrillas et ses Environs*, p. 2, plate i, fig. 1.

Vicarya bijani Verneuil and De Lorière. *Ibid.*, p. 5, plate i, fig. 3.

Vicarya strombiformis Verneuil and De Lorière. *Ibid.*, p. 7, plate i, fig. 4.

Vicarya pradoi Verneuil and De Lorière. *Ibid.*, p. 10, plate i, fig. 5.

Turritella helvetica Pictet and Renevier. Mater. pour la paléont. Suisse du ter. aptien, 1854.

Cassiope helvetica H. Coquand. Monogr. paléont. de l'ët. aptien de l'Espagne, 1866.

Cerithium lujani Verneuil. Bull. de la Soc. Géol. de France, 2e liv. Tome x, 1853.

Cerithium lucani Verneuil. Memoria geognostica de Castellon par Vilanora, 1859, plate iii, Fig. 7.

Cassiope verneuilli H. Coquand. Monogr. paléont. de l'ët. apt. de l'Espagne, 1866.

Murex strombiformis Schlotheim. 1820, Petrefact., p. 144.

Muricites strombiformis Schlotheim. Monographie der Nord-deutschen Wealdenbildung, Dunker, 1846, p. 50, pl. x, fig. 18a, b.

This form is indistinguishable from the figures of *V. lujani* and *V. helvetica* of De Verneuil and De Lorière, but without comparison of type specimens their identity cannot be positively asserted. *V. lujani* is described as follows:

"Shell elongated, with thick test; spire regular, straight, or sometimes a little pupoid; ten or twelve turns of the spire. Each turn of the spire is marked by numerous sinuous cross-striae, strongly bent inward upon the first anterior quarter of each spiral. The sutures are generally well defined." The whorls are also usually marked by two longitudinal elevated bands, one near each border, which in the apical whorls and adult specimens appear as plain elevated bands, or may be in the lower two-thirds of the shell nodular. They continue upon the buccal face or base of the shell as bands. "The lip always presents at the posterior or upper end a pronounced gutter. The outer lip has a deep, broad indentation corresponding with the termination of the basal suture line beneath the last carina or row of tubercules. The inner margin of the labial opening is thickly encrusted."—De Verneuil.

This is one of the most abundant, variable, and characteristic forms of the Trinity Division, occurring in the lowest molluscan horizons of the Glen Rose beds throughout its extent from Antoine, Arkansas, to the Colorado river in Texas. It was first figured from America by the writer in his report upon the Cretaceous beds of Arkansas under the name *Pleurocera strombiformis* Schloth., after Zittel. Although a very abundant form, the oral aperture was only recently discovered, it having hitherto been broken in the delicate structure of the specimens, and the generic position thereby made uncertain, as is attested by the widely different genera to which it has been referred in Europe.

The smallest and largest forms are void of the handsome rows of tubercules which distinguish the specimens of medium size. The larger adult specimens sometimes attain a length of two inches.

This form is of interest because it is the characteristic species of the Wealden (Lower Neocomian) beds of Europe. It may be the same as *Melania strombiformis*, first described from the Wealden strata of North Germany by Schlotheim.

De Verneuil and De Lorière, in 1886, published most excellent figures and descriptions in their paper upon *Matériau pour le Paléontologie de l'Espagne*, entitled "Description des Fossiles du Neocomien Supérieur de Utrillas et ses Environs," Paris, 1888. They review the literature of the species and refer it to the *Vicarya*, a subgenus of *Cerithida*. They make four distinct species of their specimens, which I believe to be variations of the same species, all of which except one occur in intimate association in the lower Glen Rose beds.

Professor Jules Marcou, in the previously mentioned review of my Arkansas species, asserts that the form is a *Nerinea*, but the forms are absolutely void of the characteristic folds which occur upon the columella of that genus, and hence he is mistaken.

The form occurs in great abundance at the gypsum bluffs of the Little Missouri, in Arkansas. At the plant bed locality near Glen Rose, Texas, it is still more abundant and shows the variety *helvetica* and *lajani* preserved together in great masses. At Post Mountain, near Burnet, Texas, the badly worn shells of this species occur in an agglomeration ten feet thick (plate v, fig. 7), void of other species and embedded in a matrix of the mineral grahamite. In this mass all the varieties can be found in association.

***Nerinea austinensis* Roemer.**

Roemer. Paleont. Abhandl., vol. iv, p. 295, plate 31, fig. 8.

Fragments resembling this species are abundant in the upper or Mount Bonnel beds of the Glen Rose beds, but are so poorly preserved as to render their assignment to it only provisional. I have found them in the Strontionite beds of the Colorado section, and a stratum of the beds near the summit of Mount Bonnel consists almost entirely of calcified *Nerineas*. In outer

marking they correspond to the *N. austincensis* of Roemer, originally collected from the Caprina limestone near Austin.

The *Nerineas* do not occur in the Comanché series higher than the Caprina limestone of the Fredericksburg Division and not at all in the Upper Cretaceous, where Roemer erroneously supposed this species (originally collected by Mr. Stolley) to occur.

***Neritina* sp. indet.**

A characteristic fossil of the beds at the base of the Glen Rose subdivision is a small *Neritina*. Unfortunately the writer's specimens were lost in the removal of his collections to Washington, but there are others in the United States National Museum, which he collected from Hood county for the United States Geological Survey in 1886, and it is hoped that they will be figured and described.

This form occurs throughout the basement beds in Arkansas and in Hood and Parker counties, Texas.

***Neumayria walcotti* Hill.**

Plate VIII, Figs. 1, 2, 3.

Ammonites walcotti Hill (not Sowerby). Annual Report Geological Survey of Arkansas 1888, vol. II, p. 139, plate I, figs. 1, 1a, 1b.

Nikitin (Mem. de l'Acad. St. Petersburg, 1881), defines this genus as follows:

Shell flat, widely umbilicate; convolutions thinly rounded, marked by fine falcate lines; lobes and saddles low, slightly incised; siphonal lobes longer than the first laterals; the two lateral and accessory lobes little developed.

Only one specimen of this species has thus far been discovered. It occurred in association with *O. franklini*, *Vycaria lujani*, *Eriphyla arkansensis*, and other mollusks herein described. The form very much resembles in outward appearance the figures of the genus *Oryctoceras* of Hyatt, as given by Zittel and Steinman in their Manuals, but Professor Hyatt refers to it to *Neumayria*, and contributes the following comments upon the specimen:

"Your *Ammonites walcotti* is probably a *Neumayria*. The aspect is Jurassic, but this group, Upper Jura, and the species

nearest *walcotti* occurs in the very top of the Jura of Central Volga stage, supposed by some to be similar to the Purbeck in the upturn at Malm. The obscuration of a portion of the sutures occurs over the most important part of the outer side, and the structure of the abdomen, which is rounded and has no keel, is not very consistent with the reference either to the *Neumayria* of the Jura or the so-called *Neumayria* of the Cretaceous. Nevertheless it agrees better with those of the Jura than the Cretaceous ones referred to the same genus by Nikitin."

Whatever may be the range of this genus in Europe, the writer is inclined to the belief, from the stratigraphy and association, that its occurrence in Arkansas is lowest Cretaceous, and Professor Hyatt's opinion serves to strengthen the position of the writer in his reticence in earlier papers in expressing a more definite assignment of the Trinity beds before minutely studying the accompanying faunas. The specimen was collected in the banks of Town creek, one mile southeast of Murfreesboro, Arkansas. Named in honor of Mr. C. D. Walcott.

***Acanthoceras* (?) *jus inæ* sp. nov.**

Plate VII, Figs. 1, 2, and 3.

Discoidal thin and flattened in general outline, deeply umbilicate, marked by numerous simple, gently sinuous ribs extending across the convolution and separated by shorter ribs, which disappear near the middle of the convolution; abdomen oblately rounded; suture lines not preserved in specimens found; umbilicus (fig. 2) narrow, depressed.

This species occurs in a coarse sand in the Trinity beds of Travis Peak post-office, in western Travis county, Texas, only four specimens having thus far been found. It is preserved as a cast, unpropitious for the preservation of the shell structure. It is the only ammonitic form thus far found in the Trinity Division, excepting *Neumayria walcotti*, but is of little value in determining the stratigraphic position of these beds.

Professor Hyatt has provisionally referred it to the family *Acanthoceratida*, and suggests a resemblance to *A. remondii* Gabb, from the Cretaceous of California. Our species, however, in the writer's opinion, is quite different in general aspect, being very much more flattened, more rectangular at the dorsum, and possessing wider convolutions. It has some external resemblance also to the genus *Hoplites*.

ARTHIROPODA.

Cypridea texana sp. nov.

Plate I, Figs. 3*a*, 3*b*.

Shell microscopic; elongate ovate globose, with angular appendage shown in fig. 1: opalescent or horny; cardinal margin toothless, thickened centrally; opposite or ventral margin slightly undulate; surface smooth, and not visibly punctate.

It is difficult, says Zittel, to classify with certainty even the families of the Ostracoda, owing to the fact that the shell only is preserved, which is not sufficiently differentiated to justify exact diagnosis. The species here given occurs in abundance in the Glen Rose beds, but usually only the merest outlines are preserved, or mere granules which suggest the form. In the molluscan fauna at the plant bed of the Paluxy, near Glen Rose, however, I was so fortunate as to secure a small fragment in which the shell structure was well preserved. That the species belongs to the *Cypridea* is strongly probable, resembling both the genera *Cypris* and *Cypridea*. I have placed it in the latter provisionally, because it is a marine form, occurring in masses of marine shells or mollusca, while the former genus is a fresh water one and of more recent occurrence.

There are large masses of sub-oolitic material in the Mount Bonnel beds, which are apparently largely composed of these minute Crustacea. The *Cypridea* are also abundant in the Lower Neocomian, or Wealden, of Europe.

PLANTÆ.

Undetermined species.

Plate I, Figs. 1, *a*, *b*, *c*, *d*.

(“*Goniolina*?” of author’s previous writings.)

Spherical cone-like bodies, varying in size from three-quarters to one and one-half inches in diameter; slightly elongate, oblate or depressed at upper end, with well defined circular scar showing attachment to receptacle; surface consists of minute imbricate scales, usually worn down or indistinct; scales elongate ovate or sub-diamond-shaped, elongated toward upper end, and crowded around receptacular scar; seed minute.

This problematic organism has been provisionally referred to *Goniolites* in my previous papers. It occurs from the base to the top of the Glen Rose beds as small spherical calcareous casts, and extends into the lower layers of the Comanche Peak group at Mount Barker, Travis county. The biologic relations of this organism have been a problem for years, and it has been referred to the Echinodermata, the Foraminifera, and to the vegetable kingdom by various persons to whom it has been submitted. Its occurrence in the chalky strata of the Colorado section remote from other land debris and in association with Foraminifera (*Orbitulites texana* Roemer) seemed to oppose the fact that it was a fruit or a land plant. The recent discovery by Mr. J. W. Harvey of other plants of many species in the chalky limestone beds near Glen Rose, which have recently been described in the proceedings of the United States National Museum by Professor Fontaine, dispelled the foregoing hypothesis. Immediately beneath the stratum containing the plant bed is another containing many flattened moulds of what could be mistaken for fucoid stems, and associated with these are numerous specimens of the fossil here figured. A careful study *in situ* of the surface of a stratum in which these stems were well exposed showed that they branched very much like coniferous plants. At the termination of each ramification was found one of the small spherical casts, as if the limb of a plant laden with cones had been buried in the mud and its cast preserved. Recently, however, the fruit structure has been determined in the specimens themselves as figured on plate i.

The species should be named for Professor Lester F. Ward, who has done so much for American paleo-botany and has ever encouraged the writer in his studies.

The form occurs from Glen Rose southward to the Colorado in great quantities and ranges throughout the Colorado River section.

It could be doubtfully referred to the genus *Araucarites*, which it more closely resembles than any other, although this is for the botanists to determine. This genus is abundantly represented in the Wealden (Lower Neocomian) of Europe and in the Potomac formation of this country, as described by Professors Ward and Fontaine.